S P E C I F I C A T I O N

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TO ALL WHOM IT MAY CONCERN:

BE IT KNOWN THAT WE, **Gregory Fyke**, a citizen of Canada, **Scott Woodford, James Nohrden**, and **Ramin Poorfard**, citizens of the United States of America, all residing in the State of Texas, have invented new and useful improvements in an

INTEGRATED RECEIVER DECODER FOR RECEIVING DIGITALLY MODULATED SIGNALS FROM A SATELLITE

of which the following is a specification:

BACKGROUND OF THE INVENTION

1. Technical Field

The present invention relates to receivers in general, and in particular to satellite receivers. Still more particularly, the present invention relates to a satellite receiver for receiving digitally modulated broadcast signals from a satellite.

2. Description of the Related Art

In general, digital television signals are digitally modulated when broadcast over a digital satellite communication system using phase-shift keyed modulation schemes. The digital satellite communication system typically employs a ground-based transmitter that beams an uplink signal to a satellite positioned in a geosynchronous orbit. In turn, the satellite relays the signal back to various ground-based receivers. Such digital satellite communication system permits a household (or business) subscribing to a satellite television service to receive audio and video signals directly from the satellite by means of a directional receiver antenna that is affixed to the roof or an external wall of the subscriber's residence. A directional receiver antenna constructed to receive satellite signals typically includes a dish-shaped reflector that has a feed support arm protruding outward from the front surface of the reflector. The feed support arm supports an assembly in the form of a low-noise block (LNB) amplifier having an integrated LNB feed. The reflector collects and focuses satellite signals onto the LNB feed.

The satellite signals are typically received at Ku-band or C-band. The received satellite signals are first amplified and then downshifted to a predetermined frequency band, typically in the L-band, between the range of 950 MHz and 2150 MHz. The downshifting function is typically performed within the LNB. The satellite signals are then sent via a coaxial cable to a set-top box unit located adjacent to the subscriber's

television. The satellite signal received at the set-top box maybe further downshifted to a predetermined intermediate frequency for amplification, bandpass filtering to eliminate adjacent channels and other functions such as automatic gain control, etc., with a subsequent or second down conversion to baseband and recovery of the phase-shift keyed modulated data.

The present disclosure provides an improved satellite receiver for receiving digitally modulated broadcast signals from a satellite.

SUMMARY OF THE INVENTION

In accordance with a preferred embodiment of the present invention, a receiver for receiving digitally modulated broadcast signals from a satellite includes a tuner, a demodulator, a low-noise block (LNB) controller, a voltage controller and a voltage selector implemented within a single monolithic integrated circuit device. The tuner amplifies and filters satellite signals received from a directional receiver antenna. The demodulator, which is coupled to the tuner, demodulates and decodes the received satellite signals. The LNB controller generates and detects a modulated tone to facilitate communications between the receiver and an LNB feed attached to the directional receiver antenna. The voltage selector directs the voltage controller to provide a control signal for controlling a power transistor to generate a variable voltage to the LNB feed attached to the directional receiver antenna.

All objects, features, and advantages of the present invention will become apparent in the following detailed written description.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention itself, as well as a preferred mode of use, further objects, and advantages thereof, will best be understood by reference to the following detailed description of an illustrative embodiment when read in conjunction with the accompanying drawings, wherein:

Figure **1** is a digital satellite broadcasting system to which a receiver in accordance with a preferred embodiment of the present invention is applicable;

Figure **2** is a conceptual block diagram of a satellite broadcasting receiver, in accordance with a preferred embodiment of the present invention;

Figure **3** is a block diagram of an LNB supply implemented by a DC-DC converter, according to the prior art;

Figure **4** is a functional block diagram of a receiving module of a satellite broadcasting receiver, in accordance with a preferred embodiment of the present invention; and

Figure **5** is a circuit diagram of the current sensor and the voltage sensor from Figure **4**, in accordance with a preferred embodiment of the present invention.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT

Referring now to the drawings and in particular to Figure **1**, there is depicted a block diagram of a digital satellite broadcasting system to which a receiver in accordance with a preferred embodiment of the present invention is applicable. As shown, a digital satellite broadcasting system **10** includes a satellite broadcasting station **11** having a broadcasting antenna **12** and a broadcasting satellite **13**. In digital satellite broadcasting system **10**, various television programs furnished by a program purveyor are encoded by a Motion Pictures Expert Group (MPEG) encoder (not shown) to form an MPEG transport stream (MPEG-TS). After being modulated for satellite broadcasting, the MPEG-TS is transmitted to broadcasting satellite **13** from satellite broadcasting station **11** via broadcasting antenna **12**. In addition to receiving MPEG-TS, broadcasting satellite **13** is also configured for retransmission of the received MPEG-TS to satellite broadcasting receivers, such as a satellite broadcasting receiver **14** that is installed in the premise of a satellite television service subscriber.

Satellite broadcasting receiver **14** receives modulated satellite signals via a directional receiver antenna **15** that is constructed to receive modulated satellite signals. Preferably, directional receiver antenna **15** includes a dish-shaped reflector **17** that has a feed support arm protruding outward from the front surface of the reflector. The feed support arm supports an assembly in the form of a low-noise block (LNB) amplifier having an integrated LNB feed **16**. Reflector **17** collects and focuses modulated satellite signals onto LNB feed **16**.

Satellite broadcasting receiver **14**, which is also known as an integrated receiver and decoder (IRD) or a set-top box (STB), acts as a reception terminal for receiving modulated satellite signals from directional receiver antenna **15**. The modulated satellite signals are subsequently converted to corresponding video and audio signals that

can be output on a television **18** and/or a video cassette recorder **19** that are connected to satellite broadcasting receiver **14**.

With reference now to Figure **2**, there is illustrated a conceptual block diagram of satellite broadcasting receiver **14**, in accordance with a preferred embodiment of the present invention. As shown, satellite broadcasting receiver **14** includes a tuner **21**, a demodulator **22**, an LNB controller **23**, an LNB supply **24** and a PCB power supply **25** along with other devices **26**. Tuner **21** amplifies and filters satellite signals received from a directional receiver antenna. Demodulator **22** demodulates and decodes forward error correction of the received satellite signals. LNB controller **23** generates and detects a 22 kHz pulse-width modulated signal in order to facilitate communications between satellite broadcasting receiver **14** and an LNB feed, such as LNB feed **16** from Figure **1**, attached to the directional receiver antenna. LNB supply **24** supplies a variable voltage to power the LNB feed attached to the directional receiver antenna.

With the exception of LNB supply **24**, most of the above-mentioned components within satellite broadcasting receiver **14** can be implemented within a complementary-metal oxide semiconductor (CMOS) integrated circuit device that requires less than 5 V of supply voltage. This is because LNB supply **24** must be capable of driving voltages in the range of 13 V to 21 V, making integration of LNB supply **24** into a low-voltage CMOS design prohibitive.

There are several prior art approaches for solving the above-mentioned LNB supply integration problem. For example, a DC-DC converter can be used to implement the LNB supply. Referring now to Figure **3**, there is depicted a block diagram of an LNB supply implemented by a DC-DC converter, according to the prior art. As shown, an LNB supply **30** includes a voltage controller **31**, a power transistor **32**, a voltage selector **33**, and a voltage regulator **34**. Voltage controller **31**, power transistor **32**, voltage selector **33**, and voltage regulator **34** are all implemented within a single integrated circuit device. LNB

supply **30** is coupled to external components **35** that provide a current sensing feedback to voltage controller **31** within LNB supply **30**. In addition, voltage regulator **34** provides a voltage sensing feedback to voltage controller **31** within LNB supply **30**.

The approach of implementing an integrated LNB supply with a DC-DC converter, as depicted in Figure **3**, is favorable from the standpoint that no additional requirements is placed on the transformer for LNB supply **30**. In addition, the DC-DC converter can be designed to utilize an existing voltage rail on a receiver board. However, the main drawback of implementing an integrated LNB supply with a DC-DC converter is that low-voltage CMOS designs are not permissible. Hence, in the prior art, an LNB supply within a satellite broadcasting receiver is typically implemented as a discrete device separated from other devices within the satellite broadcasting receiver.

In accordance with a preferred embodiment of the present invention, a tuner, a demodulator and a LNB controller and all functionalities of an LNB supply are integrated into a single integrated circuit device, with the exception of a power transistor and a voltage regulator.

With reference now to Figure **4**, there is depicted a functional block diagram of a receiving module of a satellite broadcasting receiver, in accordance with a preferred embodiment of the present invention. As shown, a receiving module **40** includes a tuner **41**, a demodulator **42**, an LNB controller **43**, a voltage controller **44** and a voltage selector **45**. Preferably, receiving module **40** is implemented within a single monolithic integrated circuit device manufactured under the CMOS technology.

As shown, receiving module **40** is coupled to a power transistor **46**, a line feed **47** and various external components **48**. Specifically, voltage controller **44** is connected to power transistor **46**. Also, LNB controller **43** is connected to line feed **47**. In addition, a current sensor **51** provides a current sensing feedback from power transistor

46 to voltage controller **44**. Similarly, a voltage sensor **52** provides a voltage sensing feedback from line feed **47** to voltage controller **44**.

During operation, tuner **41** amplifies and filters satellite signals that are received from a directional receiver antenna. Demodulator **42** then demodulates and decodes forward error correction of the received satellite signals. LNB controller **43** generates and detects a 22 kHz pulse-width modulated signal to facilitate communications between receiving module **40** and an LNB feed (such as LNB feed **16** from Figure **1**) attached to a directional receiver antenna. Voltage controller **44** generates a control signal to power transistor **46**. Under the control of LNB controller **43**, line feed **47** supplies a variable voltage and a variable current to power the LNB feed attached to the directional receiver antenna.

Referring now to Figure **5**, there is depicted a circuit diagram of current sensor **51** and voltage sensor **52**, in accordance with a preferred embodiment of the present invention. As shown, current sensor **51** includes a resistor **R1** connected between power transistor **46** and ground.

In addition to inductor **L1**, external components **48** also includes a diode **D1** and a capacitor **C1**. The current from inductor **L1** is sent to line feed **47** and power transistor **46**. The variable voltage sent to the LNB feed by line feed **47** is measured by voltage sensor **52**. Current sensor **52** includes two resistors **R2** and **R3** connected in series. The output voltage of line feed **47** can be measured via the voltage divider formed by resistors **R2** and **R3**.

As has been described, the present invention provides an improved satellite receiver for receiving digitally modulated broadcast signals from a satellite. The improved satellite broadcasting receiver includes a tuner, a demodulator, an LNB controller, a voltage

controller and a voltage selector implemented within a single monolithic integrated circuit device manufactured under the CMOS technology.

While the invention has been particularly shown and described with reference to a preferred embodiment, it will be understood by those skilled in the art that various changes in form and detail may be made therein without departing from the spirit and scope of the invention.